found an objection, especially where a considerable increase of the ovocyte is not followed directly by nuclear division. For the sake of harmonizing the theory with the phenomena, he suggested that synapsis is really an abortive division. This theory of synapsis naturally tends to interpret synapsis not as a stage preparing for the heterotypic chromosomes, but only as an abortive form of nuclear division. The work of POPOFF on ovogenesis of Paludina is the material on which the theory is based. POPOFF apparently considers the bivalent chromosomes after synapsis and before the growth period in ovogenesis of Paludina as tetrads. These chromosomes completely disorganize in the diplonema stage, and the heterotypic chromosomes which appear after the growth period are a new formation, without any connection with the chromosomes that emerged from synapsis. Moreover, WASSILEIFF considers that in spermatogenesis of Blatta there occurs a pulverization of chromosomes during synapsis, and he believes that it is a trace of abortive nuclear division.

GRÉGOIRE remarks, under the headings spermatogenesis, sporogenesis, and ovogenesis, that such an interpretation cannot be in harmony with the vast majority of cases of synapsis, which are believed to be an important stage in the preparation of heterotypic chromosomes. In conclusion, he emphasizes synapsis as a fundamental stage, which constitutes a primary state of heterotypic prophase and not as an abortive kinesis.—SHIGÉO YAMANOUCHI.

Soil fertility.—The Bureau of Soils is doing an excellent work in seeking the explanation of the differences in productiveness of soils along the lines of a rational physiology. In spite of various attacks upon the principles which they are developing, the work commends itself to the unprejudiced as consonant with the modern phases of physics and physiology. Two recent bulletins contain valuable reports of research. CAMERON and GALLAGHER have shown[4] that when water has been added to a given soil in such proportion that it is in its most favorable condition for working and for plant development (as determined by expert gardeners), this is also the condition when to a pointed instrument it is physically most penetrable. This "optimum" water content varies with different soils from 4 per cent. (sandy) to 120 per cent. (muck). The apparent specific gravity or volume, the rate of evaporation, and some other physical features are also definitely related to the moisture content, changing in a marked way as the optimum water content is passed. It is also shown that the optimum moisture does not vary with the plant, but what is best for one plant is best for another in a given soil. Probably the penetrability of the soil is the important factor, since roots are thus able to reach their maximum development, and so to offer the largest possible surface for the admission of water.

Another bulletin, by GARDNER,[5] reports a vast number of experiments on

[4] CAMERON, F. K., and GALLAGHER, F. E., Moisture content and physical condition of soils. U. S. Dept. Agric., Bureau of Soils, Bull. 50. pp. 70. *figs.* 33. January 31, 1908.

[5] GARDNER, F. D., Fertility of soils as affected by manures. *Idem*, Bull. 48. pp. 59. *figs.* 5. March 21, 1908.

the effects of various fertilizers, including stable and green manures, upon wheat seedlings grown in pots. These were checked by field experiments, the results being mainly concordant. Here is presented the largest number of experiments yet made under uniform conditions, and while the conditions are still too complex for full analysis, the trend of the results is clear. Though in certain cases the composition of the soil as modified by the fertilizer is an important factor, it is rarely so important as the physical change. In very many cases, indeed, the crop yield can be as greatly increased by proper manipulation of the soil as by adding any sort of fertilizer. The experiments also indicate that the fertilizing of a particular field or region is a local problem, since even the same soil "types" from different localities show different results with the same fertilizer. (This may also be taken to indicate that the basis of classification of soils used by the Bureau is unnatural.)

Everyone who is interested in the growth of plants, either theoretically or practically, should read and reflect on these bulletins.—C. R. B.

Reduction and fertilization in Polytrichum.—The mosses have received practically no attention from cytologists. The small nuclei and some difficulties in technique are doubtless responsible for this neglect. A paper by the Drs. VAN LEEUWEN-REIJNVAAN[6] presents the results of an extended investigation of *Polytrichum piliferum*, *P. juniperinum*, *P. formosum*, and *P. commune*.

In spermatogenous tissue the nucleus contains a large deeply staining mass from which the chromosomes arise. From this mass there is cut off a small body which passes out of the nucleus into the cytoplasm and divides to form two centrosomes. These behave like typical centrosomes, and in the telophase are included within the nuclear membrane. At the last mitosis they remain in the cytoplasm and become blepharoplasts. At the same time a large piece of chromatin, which may be called a *Nebenkern*, is cut off and cast out into the cytoplasm, where it gradually degenerates.

In the sporogonium the mitoses show 12 chromosomes, 4 long, 4 short, and 4 medium. In the gametophyte there are 6 chromosomes, of which 2 are long, 2 short, and 2 medium. At the last spermatogenous division the 6 chromosomes unite in pairs, fusing longitudinally, so that one counts 3 chromosomes. Hence, the sperm contains 3 chromosomes, one long, one short, and one medium. At the division of the central cell of the archegonium, the ventral canal cell and egg cell each contain 3 chromosomes, one long, one short, and one medium. These two cells fuse with each other, and the egg, formed in this manner, is fertilized by two sperms. The fertilized egg contains 12 chromosomes, 3 from the egg proper, 3 from the ventral canal cell, and 3 from each of the two sperms. The

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[6] VAN LEEUWEN-REIJNVAAN, J. and W., Ueber eine zweifache Reduktion bei der Bildung der Geschlechtszellen und darauf folgende Befruchtung mittels zwei Spermatozoiden und über die Individualität der Chromosomen bei einigen Polytrichumarten. Recueil Trav. Bot. Neerl. 4:(pp. 44. *pls.* 2). 1907.